

**WHAT IS CLAIMED IS:**

- 1    1. A method for controlling intake air of an internal  
2 combustion engine, the engine having at least one combustion  
3 chamber provided with intake means together with an intake  
4 manifold provided with a throttle valve, wherein the opening and  
5 closure timings of the intake means are adjustable entirely  
6 independently from the crankshaft position to control the  
7 amount of intake air supplied to the combustion chamber, the  
8 method comprising:  
9                 providing a response adjustment to variable valve timing  
10 control of the intake means for unthrottled intake air control.
- 1    2. The method as claimed in claim 1, wherein the step of  
2 providing said response adjustment comprises:  
3                 providing an engine response performance during  
4 unthrottled intake air control as much as an engine response  
5 performance during throttled intake air control.
- 1    3. The method as claimed in claim 1, further comprising:  
2                 separating a first operation range for unthrottled intake air  
3 control from a second operation range for throttled intake air  
4 control;  
5                 varying valve timing of the intake means with the throttle  
6 valve held in the neighborhood of the wide open throttle position  
7 to perform throttled intake air control during said first operation  
8 range; and  
9                 varying throttle valve position of the throttle valve with  
10 valve timing of the intake means held to provide a valve opening  
11 duration in the neighborhood of the minimum valve opening  
12 duration.

1    4. *The method as claimed in claim 1, further comprising:*  
2        *determining a first operation variable indicative of a target*  
3        *intake air;*  
4        *determining a second operation variable indicative of a*  
5        *target valve timing based on said first operation variable;*  
6        *wherein the step of providing said response adjustment*  
7        *comprises:*  
8        *processing said second operation variable to cause said*  
9        *response adjustment.*

1    5. *A system for controlling intake air of an internal*  
2    *combustion engine, the engine having at least one combustion*  
3    *chamber provided with intake means together with an intake*  
4    *manifold provided with a throttle valve, wherein the opening and*  
5    *closure timings of the intake means are adjustable entirely*  
6    *independently from the crankshaft position to control the*  
7    *amount of intake air supplied to the combustion chamber, the*  
8    *method comprising:*  
9        *a control for a response adjustment to variable valve*  
10      *timing control of the intake means for unthrottled intake air*  
11      *control.*

1    6. *A system for controlling intake air of an internal*  
2    *combustion engine, the engine having at least one combustion*  
3    *chamber, the system comprising:*  
4        *at least one intake valve provided for the combustion*  
5        *chamber;*  
6        *an electromagnetic driver operatively connected to each*  
7        *intake valve for opening said intake valve;*  
8        *an intake manifold with a throttle valve communicating*  
9        *with each intake valve; and*  
10      *sensors providing operation variables indicative of*  
11      *operator torque request command and engine speed;*

00000000000000000000000000000000

12        *a control unit receiving said operation variables to  
13 determine a first operation parameter indicative of target intake  
14 air based on said operator torque request command and said  
15 engine speed,*

16        *said control unit being operative to make a selection based  
17 on said first operation parameter indicative of target intake air  
18 between a first operation range for unthrottled intake air control  
19 and a second operation range for throttled intake air control,  
20 said first and second operation range being separated from each  
21 other by a threshold value of target intake air at each of varying  
22 values of engine speed, said threshold value increases as engine  
23 speed increases,*

24        *said control unit being operative to vary, with valve  
25 opening timing held in the neighborhood of the top dead center,  
26 valve closure timing of said intake valve with said throttle valve  
27 held in the neighborhood of the wide open throttle position to  
28 perform throttled intake air control upon selection of said first  
29 operation range, and vary throttle valve position of said throttle  
30 valve with valve timing of said intake valve held to provide a  
31 valve opening duration in the neighborhood of the minimum  
32 valve opening duration that is variable with varying engine  
33 speed,*

34        *said control unit being operative to determine a second  
35 operation parameter indicative of a target valve closure timing  
36 of said intake valve based on said target intake air,*

37        *said control unit being operative to provide a response  
38 adjustment to said second operation parameter indicative of  
39 said target closure timing to give a processed second operation  
40 parameter, and*

41        *said control unit being operative to control said  
42 electromagnetic driver to cause said intake valve to close at  
43 valve closure timing indicated by said processed second  
44 operation parameter.*

1    7. A method for controlling of intake air of an internal  
2 combustion engine, the engine having at least one combustion  
3 chamber provided with intake means together with an intake  
4 line having variable flow area dimensions, outside of the intake  
5 means, determined by a throttle, wherein the opening and  
6 closure timings of the intake means are adjustable entirely  
7 independently from the crankshaft position to control the  
8 amount of intake air supplied to the combustion chamber, the  
9 method comprising:

10        determining a first operation parameter indicative of  
11 target intake air;

12        determining a second operation parameter indicative of a  
13 preliminary valve closure timing for unthrottled intake air  
14 control;

15        processing said second operation parameter to provide a  
16 response adjustment to give a processed second parameter;

17        varying the valve closure timing of the intake means to  
18 close the intake means at a valve closure timing indicated by  
19 said processed second operation variable.

1    8. A computer readable storage medium having stored  
2 therein data representing instructions executable by a computer  
3 to implement unthrottled control of intake air of an internal  
4 combustion engine, the engine having at least one combustion  
5 chamber provided with intake means, wherein the opening and  
6 closing times of the intake means are adjustable entirely  
7 independently from the crankshaft position to control the  
8 amount of intake air supplied to the combustion chamber, the  
9 computer readable storage medium comprising:

10        instructions for determining a first operation parameter  
11 indicative of target intake air;

12        instructions for determining a second operation parameter  
13 indicative of a preliminary valve closure timing for unthrottled

14     *intake air control;*

15         *instructions for processing said second operation  
16 parameter to provide a response adjustment to give a processed  
17 second parameter;*

18         *instructions for varying the valve closure timing of the  
19 intake means to close the intake means at a valve closure timing  
20 indicated by said processed second operation variable.*